GE GLOBAL RESEARCH

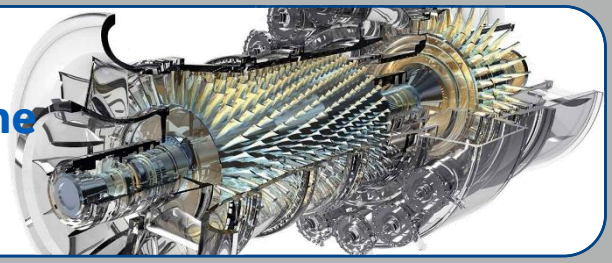
deBock – ARPA-e INTEGRATE meeting

GE Turbines and small Engines Overview

GRCTHINK

Power Generation at GE

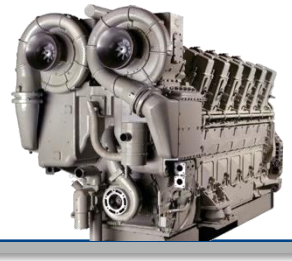
Gas Turbine



Steam Turbine

Wind Turbine

ICE Engine



Shaft power gear box

Electricity

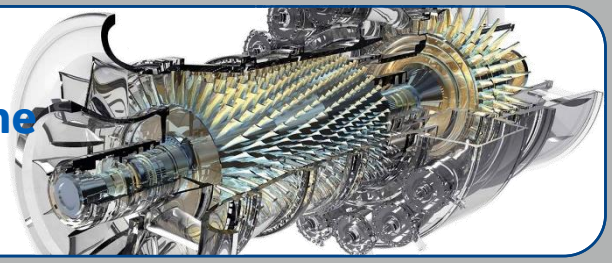
Thrust

Transportation

Wabtec CORPORATION

Power Generation at GE

Gas Turbine



Steam Turbine

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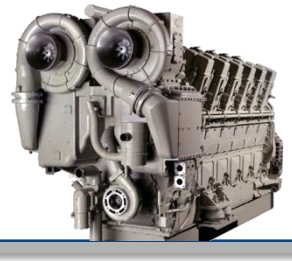


Shaft power gear box

This presentation will mostly focus on the Fuel to Shaft power generation benchmarks

Electricity

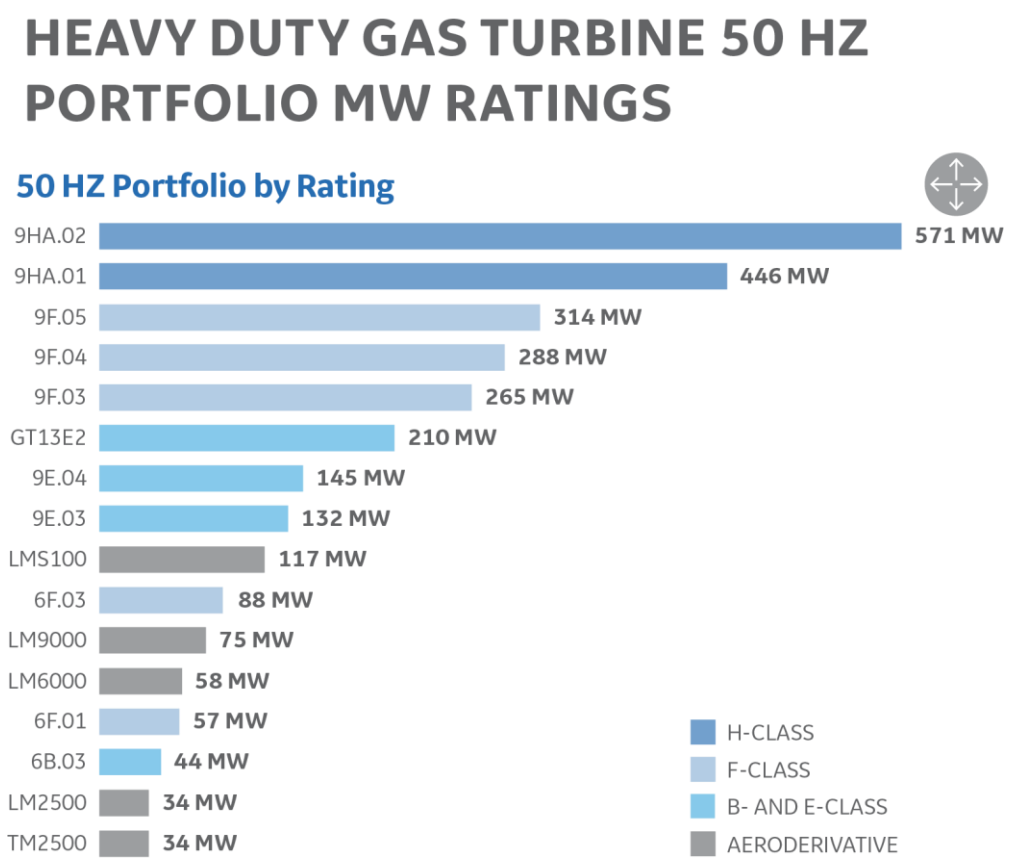
Thrust

Transportation

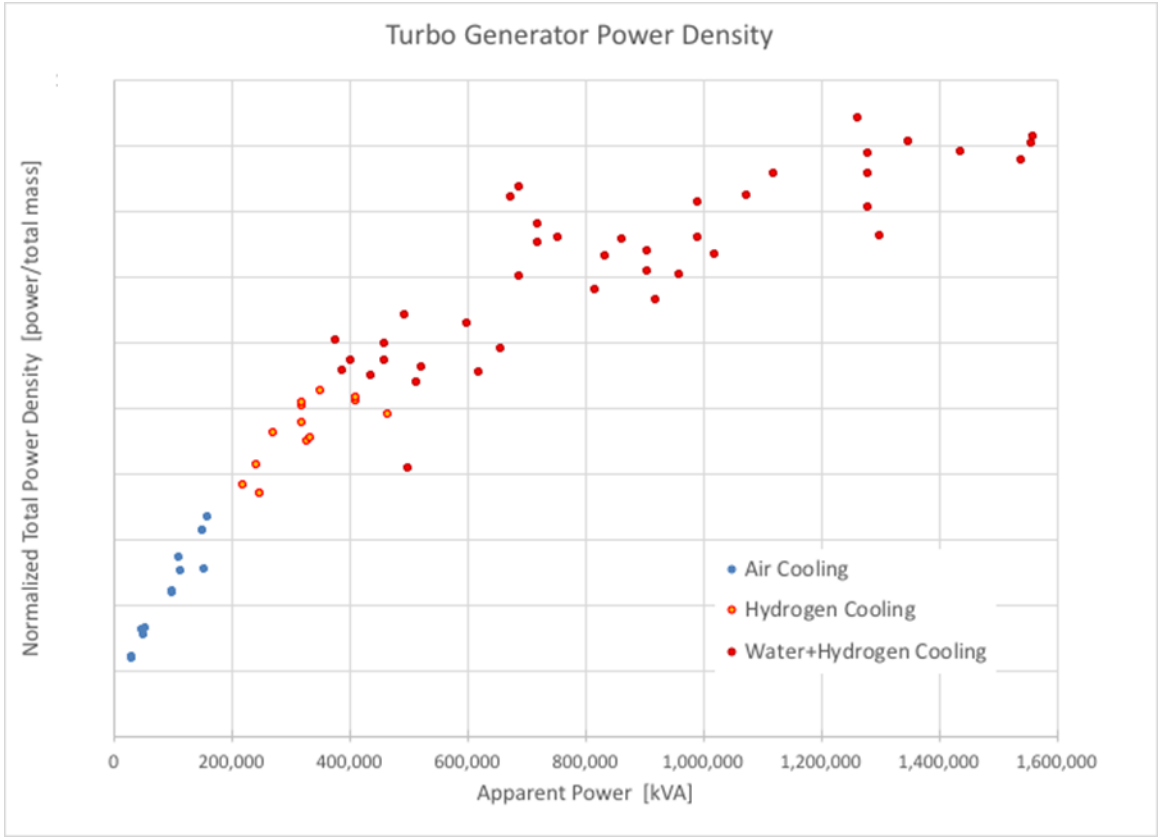
Wabtec CORPORATION

Large Turbo-Generator family

Turbines



Generators



Rotorcraft Powerplants

T408

Length: 57.5 inches (1.46 m)

Diameter: 27 inches (0.69 m)

Dry weight: 1,104.7 pounds (501.1 kg)

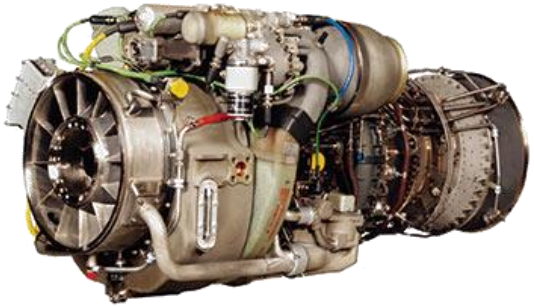
Maximum power output: 7,500 shp (5,600 kW)

Specific fuel consumption: ~0.4 lb/hp-h**

Power-to-weight ratio: 6.8 shp/lb (11.2 kW/kg)

CH-53K King Stallion

*) estimate from 18% reduction over T64 engine



T700/T6E

Length: 48.2 in (1,220 mm)

Diameter: 25 to 26 in (640 to 660 mm)

Dry weight: 537 lb (244 kg)

Maximum power output: 2,380 shp (1,775 kW)

Specific fuel consumption: 0.433 lb/hp-h

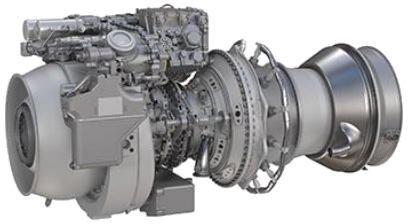
Power-to-weight ratio: 4.48 shp/lb (7.37 kW/kg)

AH-1 SeaCobra / SuperCobra

UH-60 Black Hawk

Boeing AH-64 Apache

Rotorcraft Powerplants



T901 - estimates

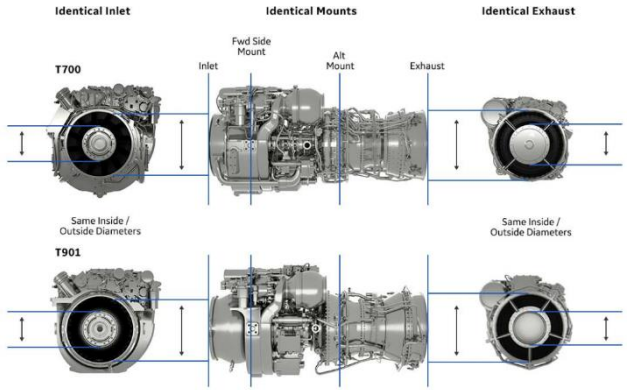
Same dimensions (approx. as T700)

Length: 48.2 in (1,220 mm)*

Diameter: 25 to 26 in (660 mm)*

Specific fuel consumption: <0.4 lb/hp-h*

Maximum power output: *~3khp class* *

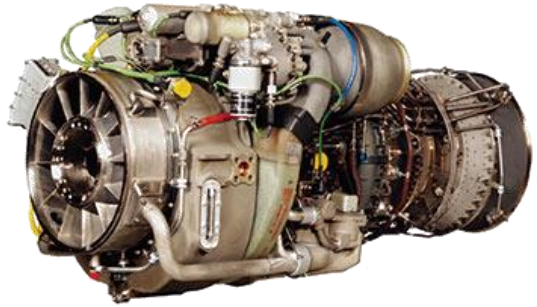


50% More Power

25% Better Fuel Efficiency

**) derived from scaling rules to T700*

Same volume
+50% power
+25% SFC



Commercial versions: CT7

CT7-8A6:

48.8 L x 26W x 25h = 520 liters (31720 in^3)
Maximum power output: 2,695 shp
Weight: 542 lbs
Power-to-weight ratio: 4.97 shp/lb (8.20 kW/kg)

CT7-2E1:

47L x 26w x 25h = 500 Liters (30,550 in^3)
Maximum power output: 1983 shp
Weight: 491 lbs
Power-to-weight ratio: 4.04 shp/lb (6.6 kW/kg)

CT7 family includes an integral inlet particle separator filtration system which adds ~5% weight, ~10% volume, and reduces shp ~3%.

Introducing **GE Catalyst**™ advanced turboprop engine

(Formerly GE ATP)

- **Clean sheet** engine design
- **Step-change** in performance
- An engine **born digital**
- Enabled by **Additive** technology
- ~(60)% engine-related tasks, improving **pilot productivity**

First engine run December, 2017

100+
PATENTS
in GA turboprop space

10%
MORE POWER
at altitude

20%
LOWER
mission fuel burn

855→12
MANUFACTURED PARTS
subtracted by additive process

First all-new BGA turboprop engine in 30 years

https://www.ge.com/sites/default/files/ge_webcast_presentation_06192013_David_Joyce_0.pdf

GE Catalyst

Approximately same dimensions as PT6

Length: 71.6 in

Diameter: ~26 in

Weight: 625 lbs

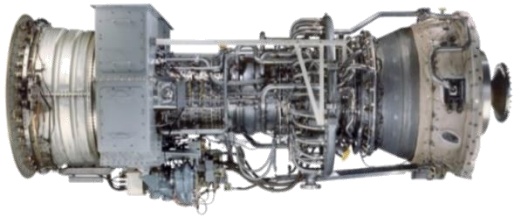
Specific fuel consumption: <0.5 lb/hp-h*

Maximum power output: 1,600 shp (1,190 kW)

Power-to-weight ratio: ~2.6 shp/lb (4.2 kW/kg)

* Estimate relative to PT6

Large Aeroderivatives for Marine



LM6000PG

193.5 L x 85W x 81H

Dry weight: 16,340 pounds (7,411 kg)

Maximum power output: 70,656 shp (52,689 kW)

Specific fuel consumption: 0.335 lb/shp-hr

42% thermal efficiency

LM2500

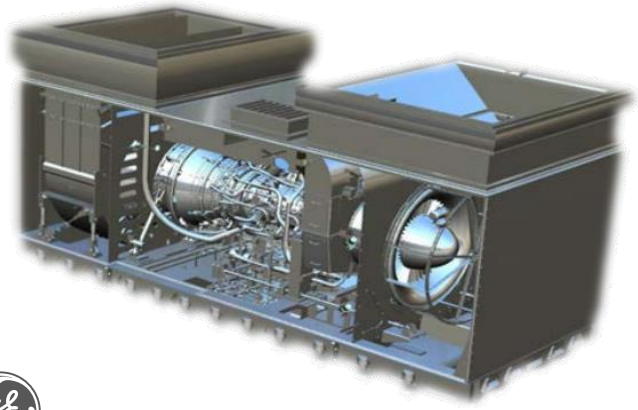
324 L x 108 W x 120 H

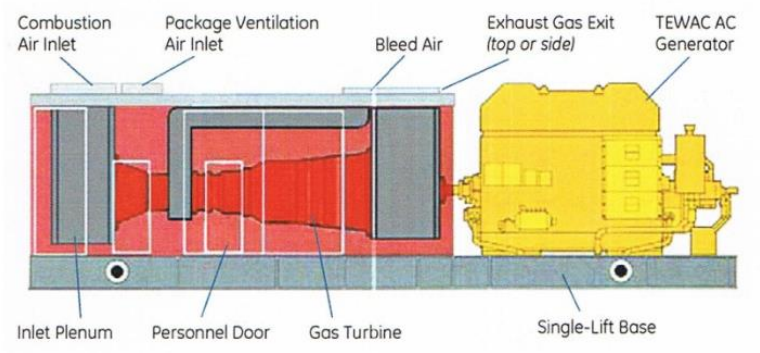
Dry weight: 48,000 pounds (22,000 kg)

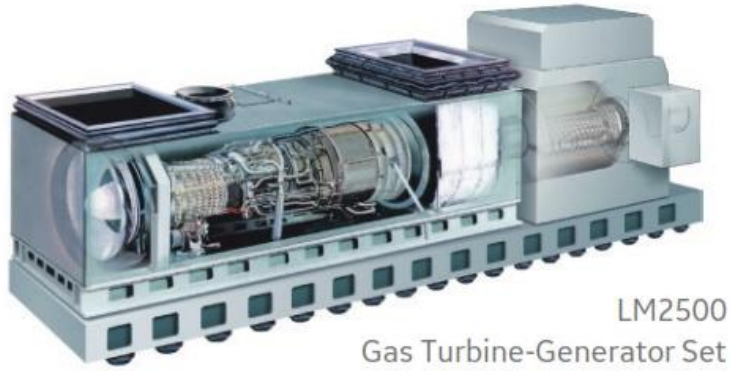
Maximum power output: 33,600 shp (25,060 kW)

Specific fuel consumption: 0.373 lb/shp-hr

36% thermal efficiency



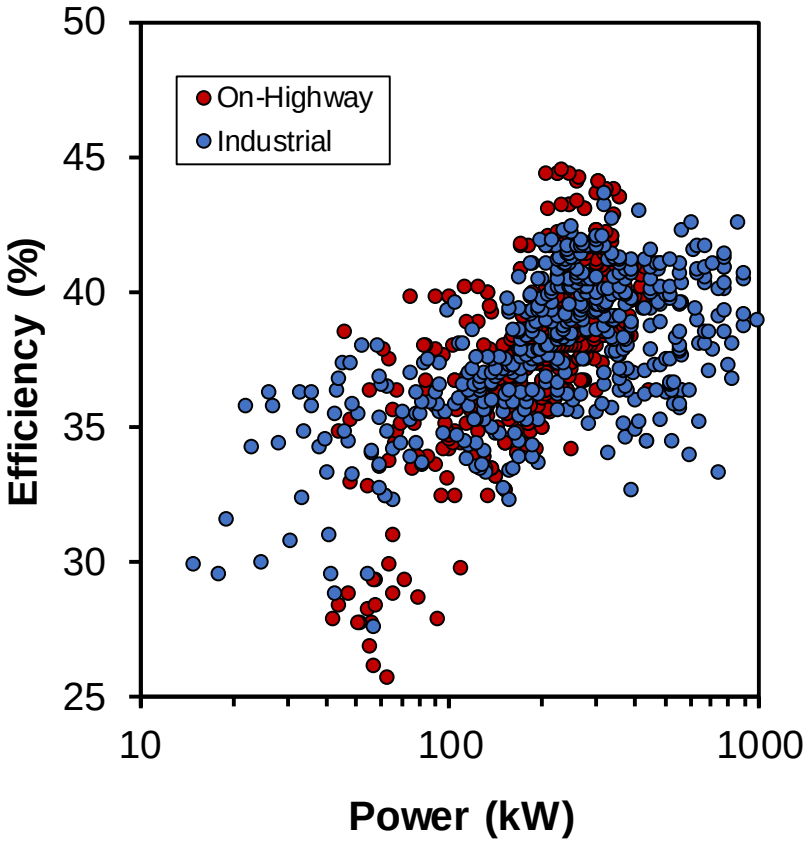


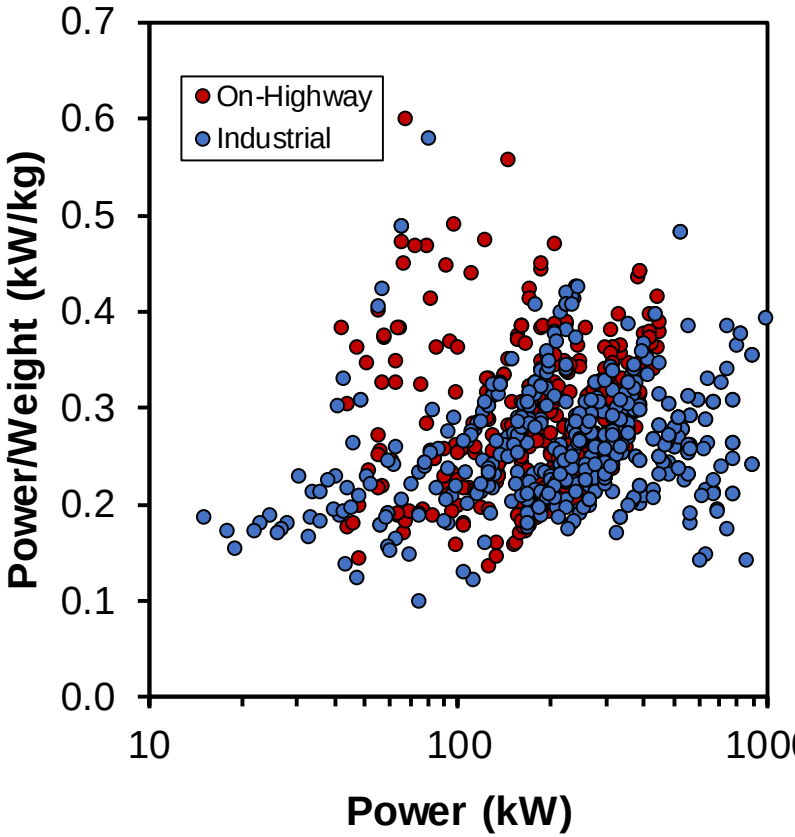


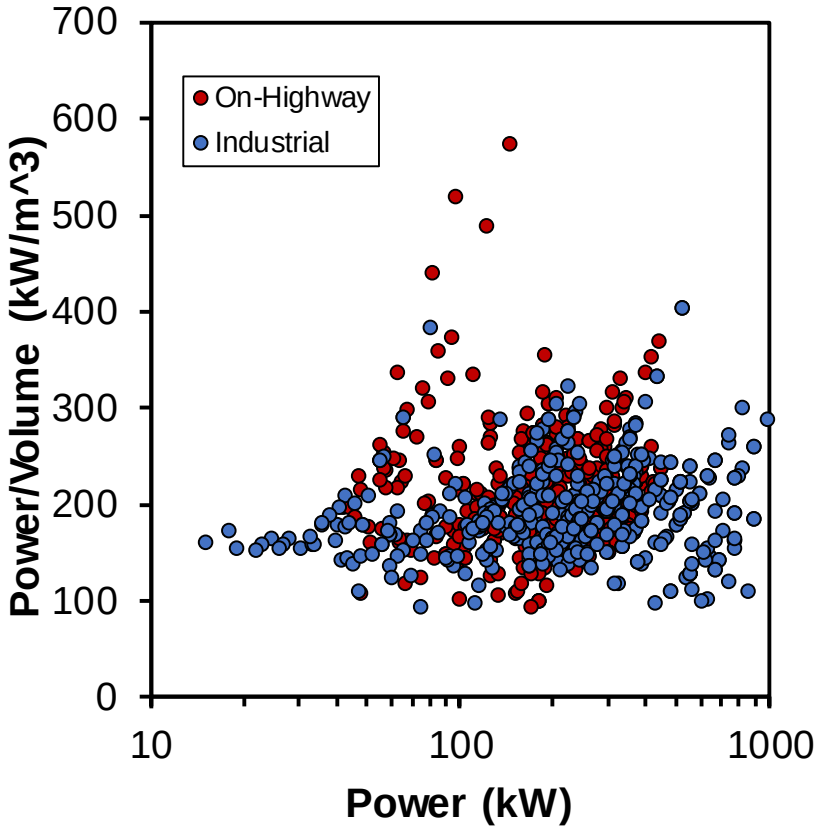
LM2500
Gas Turbine-Generator Set

Representative Reciprocating Diesel Engine Data

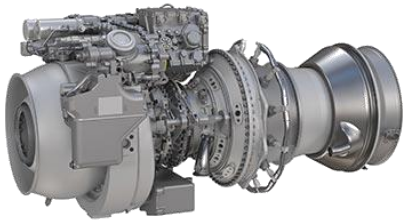
Data sets of 40kW to 1MW 4-stroke diesel engines data from public sources from many manufacturers







Wrap-up



Small engines technology important for rotorcraft and marine

- GE T408 : ~ 11 kW/kg
- GE T901 : <0.4 lb/shp-hr

} Leading metrics

New technologies being added for next generation

- GE Catalyst

Land based larger units and Diesel units typically have lower power density but outperform on other metrics, i.e. reliability, efficiency, total power output